

# Knowledge flow and exchange in interdisciplinary primary health care teams (PHCTs): an exploratory study

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**Objective:** Improving the process of evidence-based practice in primary health care requires an understanding of information exchange among colleagues. This study explored how clinically oriented research knowledge flows through multidisciplinary primary health care teams (PHCTs) and influences clinical decisions.

**Methods:** This was an exploratory mixed-methods study with members of six PHCTs in Ontario, Canada. Quantitative data were collected using a questionnaire and analyzed with social network analysis (SNA) using UCInet. Qualitative data were collected using semi-structured interviews and analyzed with content analysis procedures using NVivo8.

**Results:** It was found that obtaining research knowledge was perceived to be a shared responsibility among team members, whereas its application in patient care was seen as the responsibility of the team leader, usually the senior physician. PHCT members acknowledged the need for resources for information access, synthesis, interpretation, or management.

**Conclusion:** Information sharing in interdisciplinary teams is a complex and multifaceted process. Specific interventions need to be improved such as formalizing modes of communication, better organizing knowledge-sharing activities, and improving the active use of allied health professionals. Despite movement toward team-based models, senior physicians are often gatekeepers of uptake of new evidence and changes in practice.

## INTRODUCTION

Health care in Western countries continues to increase in complexity, a situation intensified by advances in technologies of care and an increased availability of medical information for clinicians and patients. These complexities, and their added costs, have placed increasing demands on the primary health care (PHC) system, a fact reflected in recent national [1–4] and international [5, 6] policy reviews. In Canada, provinces and territories have set out to explicitly reform the structure of primary care, with one goal: to better integrate primary, secondary, and tertiary forms of care. Other stated (and not stated) goals include new (presumably more cost-effective) payment approaches. These reforms typically involve groups of physicians and/or blended payment models to replace current solo practice fee-for-service models, greater involvement of multidisciplinary teams, financial incentives for delivery of preventive services, reduction of wait times for and increased access to primary care physicians in community settings (rather than costly emergency department visits), and increased after-hours access to primary care [7].

There is a need to evaluate new practice models as they evolve, while also understanding parallel processes, including strategies for evidence-based practice (EBP) that are increasingly expected to guide clinical decision making [8]. The purpose of this study

### Highlights

- Practitioners are often overwhelmed by the amount and frequency of knowledge and evidence in health care.
- Sharing new clinically oriented knowledge in primary health care teams (PHCTs) occurs most often through informal, nonstructured channels.
- Residents often facilitate information discovery and sharing.

### Implications

- This study demonstrates the current uneven pattern of knowledge flow among primary health care professionals and opens up the potential and important role of information specialists in PHCTs.
- Social network analysis can provide valuable insight into the knowledge flow of clinical teams. By seeing how information flows, barriers to and facilitators of improved processes and better use of knowledge in PHCTs can be seen.
- There is a lack of organization surrounding knowledge flow in PHCTs and a desire for more consistency in knowledge sharing. PHCTs and health care organizations need to consider making knowledge sharing a formal part of organizational activity and policy.



Supplemental Figure 1 and a supplemental appendix are available with the online version of this journal.

was to examine how new clinically oriented research knowledge enters, flows through, and is exchanged in primary health care teams (PHCTs).

## Team models of primary health care

PHCTs are interprofessional teams that include, but are not limited to, physicians, nurse practitioners, nurses, physical therapists, occupational therapists, and social workers, who work collaboratively to deliver coordinated patient care [9]. Team-based models of PHC delivery have been created to achieve (or work toward) several benefits to the health system, health care providers, and patients, including better coordination of care, increased focus on collaborative problem solving and decision making, and a commitment to patient-centered care [10]. Ideally, these benefits will produce reduced mortality, improved quality of life, reduced health care costs, and a more rewarding professional experience [11]. For example, the province of Ontario, Canada, has recently emerged from intensive investments in primary care renewal, with significant emphasis on the creation and maintenance of PHCTs, which they call “Family Health Teams (FHTs),” that seek to address these needs and objectives [12].

Recent studies show that these kinds of teams improve outcomes in specific areas of care, such as mental health and chronic disease prevention and management [7], and contribute to patient satisfaction, higher job satisfaction, and income [13]. However, others note that PHCTs have faced several hurdles in their formation, including establishing effective interactions [14], combating traditional physician-dominated hierarchies [15], resolving role confusion or definition [16], and clarifying uncertain team function and structure [17]. In turn, these barriers can affect the flow of information and knowledge in health care teams. On the other hand, improving the structure and function of teams can improve professional interactions, knowledge flow [18], and, presumably, quality of care. Additional research examining the overall effectiveness of FHTs is required [19].

Other types of professionals, like clinical librarians, might play an important supporting role for PHCTs. While the way that clinical librarians or “informationists” might be integrated into the team or the most useful functions they might fulfill is still not clear [20], evidence of the benefits of clinical librarians is building, including the potential to improve patient care processes [21], help with health professional training and education [22], and provide fast, evidence-based decisions [23].

## The evidence imperative

Concurrent with PHC reforms is the increasing emphasis on EBP or, more broadly, evidence-based health care [24]. Sometimes also called knowledge translation, development and evaluation of processes and tools for EBP have been the focus of active research over the past 15 years, contributing to a literature base replete with discussion about developing clinical practice guidelines, clinical protocols, patient decision-aids, and so on, and how to best implement these in practice using old and new technologies [25].

However, lack of time, personal initiative, team dynamics, and institutional culture impact clinical decision making [26]. Information overload—starting with too little information and quickly becoming overwhelmed by peripheral or unreliable information—has also been identified as a barrier to EBP [27]. A study with pediatricians, for example, found that an average of 1.2 resources were accessed for each clinical question [28]. Much of the literature on information-seeking behaviors of physicians and other health care providers points to the fact that multiple sources of information are used [29–31]. As research literature continues to expand, one of the biggest challenges is how to best access and integrate research evidence with existing knowledge to improve practice [24, 32].

The complexities of interrelated EBP barriers present particular challenges to evaluating the uptake and impact of new research as well as (re)define the roles of information professionals in this evolving landscape. Clinicians are known to turn to colleagues when seeking out information [33]. This process has been discussed in primary care physicians using social network analysis (SNA) [34], where expertise and experience, as well as geographical location, play a role in how information is obtained. This potential point of intervention for EBP, and information and knowledge uptake and use more generally, needs to be better understood in the context of new organizational forms such as PHCTs. This is an essential first step before positioning the potential role of information professionals in PHCTs. SNA has not been widely used to analyze these kinds of issues in health care practices [35–37]. In the present study, the authors examined how research knowledge flowed into and through six PHCTs in Ontario and in what way it might have influenced clinical decision making.

## METHODS

This study employed a concurrent mixed-methods exploratory design [38]. Data were collected through social network questionnaires and qualitative semi-structured interviews. SNA is uniquely suited to describe, explore, and understand structural aspects of relationships [39, 40], so it was used to identify how information flowed in the PHCTs. Semi-structured interviews were used to understand participants’ experiences with knowledge processes and to examine certain patterns of behavior emerging from the SNA findings related to research and clinical decision making [38]. SNA questionnaires and interviews were administered concurrently, analyzed independently, and considered simultaneously during interpretation of findings [38].

## Setting and sample

PHCTs were purposively selected from among Ontario FHTs that, through a larger research project, self-identified as having an interest in participating in research. The main inclusion criterion was having a minimum of five health care professionals represent-

**Table 1**  
Interview questions

Question	Probes
1. First, I'd like you to think back to the last time new clinical research for patient care was introduced to your team, like, for example, at a group educational session. Can you describe the last time that happened?	a. When was this? b. What was the topic area? c. How did the new information come into the team? How did you hear about it? d. How, exactly, was patient care changed (or not)? e. Did the whole process go well? Why or why not?
2. Was the case you describe above pretty typical of how new clinical research evidence comes into the team? If not, please describe why.	Has the need for new clinical information ever come about because of a complex or challenging patient? Can you tell me about that?
3. In general, how well do you think your team keeps up to date on new clinical research evidence about chronic disease management?	a. Who takes the lead on this? b. How often does this usually happen? c. How are team members kept up to date (i.e., specific communication methods: team meetings? electronic communication? continuing education sessions? etc.)? [Note to interviewer: Probe for each if not being addressed] d. How is the decision to adopt new approaches usually made? e. Does this process work for you? Why or why not? f. Would the addition of specific information tools or resources facilitate this process? If so, please specify (probe for types of resources or tools, new professional roles; e.g., a librarian or information specialist, a clinician with special training in information retrieval and appraisal, etc.).
4. Is there any disagreement in the team regarding whether and how new clinical research evidence is found, communicated, or used?	If so, please describe how this usually happens, its impacts, and whether or how disagreement is resolved.

ing more than two professional roles overall (e.g., physicians, nurses, nurse practitioners, dieticians, or social workers). Six individual teams from two PHC practices (or sites) qualified and participated in the study. The first site (Site 1) was a family medicine teaching centre and had twenty-seven professionals structured into five teams, with seven allied health professionals (e.g., registered dietician and social worker) working across teams. The second site (Site 2) was a smaller rural practice and included fourteen professionals structured as one team.

### Data collection

Data collection started in January 2009 and was completed by May 2010. Consenting health care professionals were interviewed using (1) an SNA questionnaire (Appendix, online only) and (2) a semi-structured interview guide (Table 1). The SNA questionnaire was used to quantify the types and number of relationships and interactions between team members. It had been previously piloted [41], and questions were refined to suit this target group. The interview guide was developed by the authors based on literature (presented above) and explored individuals' experiences related to knowledge seeking and flow, and clinical decision making by their team. Participants were asked open-ended questions and, where necessary, probed for further discussion. Participants were free to answer questions as they interpreted the questions. Data were collected by the first author and several trained research assistants; the questionnaires and interviews were administered in person, in one sitting. This study was approved by Western University's Health Sciences Research Ethics Board (protocol #15216e).

### Data analysis

SNA is the study of structural relationships among members in a team. The responses to two of the

questions asked of participants ("typically give research information/knowledge to this person" and "typically seek research information/knowledge from this person") are reported in this paper.\* The response rate at Site 1 was 74%, and 57% at Site 2. Further investigation revealed that some rotating residents were new and did not feel that they were able to comment on information relationships. Responses from participating team members were used to construct an understanding of the whole network. Site 1 was treated as one team because participants from each of the five teams indicated that they worked closely with each other (geographically and professionally).

Giving and seeking research knowledge represent two different types of information relationships. The density of the team (a measure of the extent to which all members of a team are interconnected out of all possible connections) was calculated to determine the team cohesiveness related to giving and seeking research. In-degree network centrality was calculated to understand what the extent of equal participation was or whether central players existed among team members in giving and seeking research. It is a robust measure to use when response rates are moderate [42]. Relationships were considered directed and normalized measures calculated using the software UCInet [43].

### Qualitative interviews

Interviews were de-identified and transcribed verbatim to minimize threats to accurate description, then organized and analyzed using NVivo 8. A coding scheme was developed through independent review of a selected sample of transcripts by two members of the research team. To ensure reliability of the coding process and representativeness of the coding scheme

\* The social network questionnaire had twenty-one questions, and therefore twenty-one possible networks for analysis. For the purpose of this paper, we have presented the two that we feel best align with the qualitative results. Analysis of the remaining questions is ongoing in the larger research program.

**Table 2**  
Participant demographics

	Site 1										Site 2		Total	
	T1		T2		T3		T4		T5		Other		Total	
	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)		
Total members	4		4		4		4		4		7		27	41
Participating members	4	(100%)	2	(50%)	4	(100%)	3	(75%)	4	(100%)	4	(57%)	21	29 (71%)
Role/Profession														
Nurse	1	(25%)			1	(25%)	1	(25%)	1	(25%)	1	(14%)	3	8 (20%)
Medical doctor	1	(25%)	1	(25%)	1	(50%)	1	(25%)	1	(25%)	1	(14%)	3	9 (22%)
Resident	2	(50%)	1	(25%)	2	(50%)	1	(25%)	2	(50%)				8 (20%)
Allied health											2	(28%)	2	4 (10%)
Years with team														
<1	2	(50%)	1	(25%)	2	(50%)	1	(25%)	1	(25%)	1	(14%)		8 (20%)
1–3	1	(25%)			2	(50%)			3	(75%)	2	(28%)	5	13 (32%)
3–5			1	(25%)									3	4 (10%)
>5	1	(25%)					2	(50%)						3 (7%)

and to reduce threats to interpretation, each transcript was coded independently by at least two researchers. Basic content analysis identified key themes arising in each area of interest [44]. Supporting exemplar quotations drawn directly from participants are presented in this paper (note that colloquial usage of terms such as “like” and “you know” were removed for readability). As a form of member checking, summaries of findings were sent to all interested participants [45, 46]; however, no feedback was received.

## RESULTS

In total, 28 participants (8 nurses, 9 physicians, 7 residents, and 4 allied health professionals) from 6 PHCTs participated in this study (Site 1: 5 teams:  $n=19$ , response rate 74%; Site 2: 1 team:  $n=8$ , response rate 57%) (Table 2). In looking at our whole study, although not every team had all professionals participate, we did have representation from all health care professionals in the PHCT; in other words, every team was represented. All professionals were encouraged to participate. While some professionals on some teams chose not to do so, the overall sample includes representations from all health care professionals.

Within knowledge flow, we looked at the role played by various kinds of team members, and within knowledge sharing, we looked at the venues in which the sharing occurred. Instead of presenting the results question by question as per the interview guide, we present the aggregated results of both the interviews and SNA data regarding knowledge flow and knowledge sharing. Our results are organized into subheadings according to the major themes or topics discussed by our participants: the flow of knowledge, venues for knowledge sharing and acquisition, and adaptation and application of knowledge in decision making. Table 3 summarizes the interview themes and integrates them, where appropriate, with the key results from the SNA, with a final column summarizing the interpretation of these synthesized findings.

## The flow of knowledge

Participants from both sites agreed that the way in which research evidence enters the team as a day-to-day process was not obvious: “there is no system for new research coming in” (Physician, Site 2). Both sites demonstrated low-density scores for information flows related to giving research knowledge to individuals (Site 1: 0.07, Site 2: 0.12) and seeking out research knowledge from individuals on their teams (Site 1: 0.07, Site 2: 0.10). (Figure 1 [online only] is a sociogram of the “seeking out research knowledge” network; it is provided as a graphic depiction and example of the network relationships. The sociograms for the other relationship, giving knowledge [available on request], look very similar with similar outliers and network structure.) These low density scores confirm that interactions related to giving and seeking out research knowledge were not paramount in these teams. There were likely other more prominent reasons why members connected with their team members. At Site 1, team members generally participated equally in sharing research with their colleagues (network degree centrality: 0.08, range 0–0.15), while at Site 2, sharing research across team members was somewhat more unequal (network degree centrality: 0.37, range 0–0.46).

When asked about research evidence (generally in question #1 and/or 2), nearly all participants exclusively discussed the application of and adherence to clinical practice guidelines. Obtaining new research was perceived to be a shared responsibility among team members, although residents (trainee physicians), who “are keen for knowledge...(and) motivated,” were often described by participants, especially by senior doctors, as being major contributors to the process of knowledge acquisition and sharing. Residents were integral in learning sessions. Educational requirements, such as grand rounds and teaching-based research sessions, contributed to a relatively high through-put of knowledge. Participants from the



**Table 3**  
Summary of results

Main theme	Interview question (primarily)	Key interview themes	Related social network analysis (SNA) result	Conclusion
The flow of knowledge	1 and 2	<ul style="list-style-type: none"> <li>The degree to which research evidence enters the team as a day-to-day process was not obvious</li> </ul>	"External professionals" were called on for learning and knowledge acquisition	Knowledge flow is not obvious to team members; the important role of external professionals suggests a potential and important role of information specialists
Venues for knowledge sharing and acquisition	3	<ul style="list-style-type: none"> <li>Allied health professionals, such as registered dietitians and social workers, often acted as purveyors of information</li> <li>There were inconsistency and uncertainty regarding when and where "sharing knowledge as a team" happened</li> </ul>	Not applicable	There are a lack of organization and structure to facilitate knowledge flow and a desire for more consistency in knowledge sharing
Adaptation and application of knowledge in decision making	4	<ul style="list-style-type: none"> <li>Applying knowledge to change clinical practice was the responsibility of the team leader, primarily identified as the senior physician</li> <li>Changes to clinical practice were often attributed to new clinical research evidence</li> </ul>	Not applicable	Organizational structure and information and decision processes are often cited as barriers to successful implementation of new evidence

academic or teaching setting (Site 1) commonly discussed that nearly every day (particularly for physicians and residents) they were learning, teaching, and/or discussing clinical information. Senior physicians (team leaders) were often sought by residents to confirm or discuss new knowledge. SNA data showed that the seeking out of research knowledge occurred slightly more unequally by Site 2 members than Site 1 members (Site 1: network degree centrality: 0.16, range 0–0.23; Site 2: network degree centrality: 0.23, range 0–0.31). Despite participants saying they did not necessarily go to one person or colleague for information more than others, SNA data from Site 2 showed that 3 members (2 physicians and 1 senior nurse) in particular seemed to exhibit relatively higher prestige as a research source (degree centrality scores of 0.31, 0.23, 0.23).

Knowledge was also shared between team members in the form of mentorship. This happened mainly with senior staff (often senior residents) mentoring junior staff members. Similar informal information pathways existed between physicians and residents.

From our interviews, we found that even among nurses themselves, there was a lack of agreement on the role of nurses in information processes (usually addressed in question #3). While there was a lack of consistency in specific roles for nurses in team knowledge sharing, there was a larger variety in the kinds of roles taken on by nurses in information sharing. SNA data highlighted this for Site 2, where 2 team members (both nurses) had relatively high-degree centrality scores of 0.46 and 0.31, indicating their higher level of direct ties with others with respect to giving research, and were therefore seen as more prominent in this regard. Nurses seemed to share information more readily with the senior physician and fellow nurses on a one-on-one basis.

Nurses were also referred to as an intermediary between attending physicians and administrative support staff. In the academic setting where resident turnover was more prevalent, the nurses were seen as "the glue" of individual teams, which was highly valued by team members:

And particularly about patients I find that the nurse is the glue to the team, so even though I might...have missed out on something, but (the nurse) knows these families well. (Physician, Site 1)

Nurse practitioners seemed to be better connected and information "savvy" (knowing where and how to access information for a variety of areas) and have a rapport and experience with other nurse practitioners. This sort of information sharing network was valued by the rest of the team, as described by one participant:

nurse practitioners...through their ongoing education programs...are very aware of the latest clinical research, so I think I have a lot of respect for our nurse practitioners because I think they're very evidence based driven, and they are providing very comprehensive care...I would say that they are instrumental in really trying to keep us at a standard. (Nurse, Site 2)

However, the active team role of nurse practitioners in knowledge acquisition and sharing was also felt by some nurse practitioners to be a barrier to information sharing outside of the team. For example, it limited the amount of time nurse practitioners had to focus on personal research programs and to publish results.

Allied health professionals on the team, such as registered dietitians and social workers, often acted as purveyors of information. SNA data from Site 1 showed more connections with allied health professionals not directly in the health care team. These "external professionals" were called on for learning and knowledge acquisition. Team-based allied health

professionals indicated that they were not used by the team as a resource as much as they would have liked, often feeling like they were “pushing” information to the team but not part of any deliberate knowledge-sharing processes.

### Venues for knowledge sharing and acquisition

There was inconsistency and uncertainty regarding when and where “sharing knowledge as a team” happened. For the majority of participants, knowledge sharing occurred informally (e.g., hallway chats) despite the availability of formalized tools, such as meetings or electronic venues (e.g., wikis). Fewer participants talked about knowledge sharing through traditional means, including written (chart) reports and teaching sessions. Participants discussed the increased use of electronic modes of communication such as email as well as notes and attachments (e.g., articles) embedded in electronic medical records as methods for sharing knowledge. Teams had regular meetings that were meant to be a forum to introduce and discuss a broad range of information (most often clinical in nature, but also pharmaceutical and guideline based); however, the organization and maintenance of these meetings varied among teams, and, in turn, there seemed to be no consensus on the function or purpose of the meetings. In addition, there was little agreement about the goals or outcomes of these processes and a general confusion from the team about who attended which meetings and who was meant or expected to participate. For all teams, meetings occurred weekly or biweekly, with targeted educational opportunities occurring approximately once per month. When asked about these meetings (generally in question #3), most of the sessions were described as “open,” in that anyone could attend. External options for knowledge sharing and acquisition of research knowledge, such as continuing medical education sessions either at connected clinics or at a nearby hospital, were available and regularly attended by the majority of participants. Further, nonphysician team members reported the opportunity to attend education sessions that were conducted by or for the team residents.

In addition to regular team meetings, participants in all six teams indicated that experts were also brought in to conduct information sessions. “Experts” included both in-house and external professionals in a given field, as well as pharmaceutical representatives (reported more commonly by Site 2 participants). Participants at both sites discussed a relative uneasiness with having learning sessions sponsored by pharmaceutical companies because of perceived ethical issues and biases toward a particular treatment or drug:

we’ll have a drug lunch, so the drug reps will bring in lunch and we’ll have a speaker, but then again that information is a little bit biased in that aspect, a lot of people don’t even go for that reason. (Physician, Site 2)

Participants spoke of a desire for more formalized knowledge-sharing processes, but there was no consistency around what that process might look like. In general, team members supported the idea of a role for a dedicated information specialist (though there was little consensus on what that might look like) and were attracted to the idea of a flexible interactive whole-team approach to learning and knowledge sharing:

but if there was a system where every other Tuesday there was lunch and it was with reliable information, I think that would be a great, because a lot of people manage to show up. (Physician, Site 2)

Nearly all participants across all teams agreed that the Internet and associated electronic services were integral in their own personal knowledge acquisition. Most commonly, participants talked about getting information from the Internet in general, as well as through access to online databases, journals, email alerts, and new evidence-based, peer-reviewed services, such as UpToDate and the Ontario Telemedicine Network. Bulletin boards, flyers, notices, and other “non-direct communication” tools were also mentioned.

### Adaptation and application of knowledge in decision making

The majority of participants stated (usually as part of the response to question #4) that applying new knowledge to improve clinical practice was the responsibility of the team leader, primarily identified as the senior physician. As one physician shared:

I mean okay there’s been disagreements in terms of maybe clinical practice, and the research, we’ve talked them out, we’ve discussed the pros and the benefits or the risks of certain things, the bottom line is in terms of providing clinical care to patients, that’s my, that’s my domain and so ultimately the patient, the residents will have to follow what I’m most comfortable providing for patient care. (Physician, Site 1)

Changes to clinical practice were often attributed to new clinical research evidence; however, the process by which this happens was not clearly articulated. In the immediate sense, most change was said to occur based on new or updated clinical practice guidelines. However, in the absence of new guidelines, change appeared to be more flexible: Some participants discussed critically evaluating new research, discussing it with colleagues, and then adding it to their treatment repertoire. Participants described change in patient care occurring collaboratively with the team nurse, and, in one instance, change was described as happening “organically.” As one nurse noted:

Yea, I mean occasionally it will be experimental, so if we have been seeing a trend then we will sometimes say or I’ll say I want to try this with patients and I’ll run it by [the senior physician] and he’ll say no problem, go for it, and

then I will just keep sort of an informal tally of who I'm making these changes on so it's discussed. (Nurse, Site 1)

Participants saw the regular turnover of residents (typically every four months) as a potential barrier to EBP change. For example, discussions and processes for new practices might be identified while one group of residents was on the team, but the actual change to practice might be delayed until the arrival of the new residents.

## DISCUSSION

The emerging policy discourse about effective models of multidisciplinary primary care presents an opportunity to examine and then refine the flow of research and knowledge into practice as these models are being structured. This study found that respondents in our sample of PHCTs generally provided research information to only a few individuals on their teams and that, overall, only a few individuals were providing the information. Analysis revealed that key players in the knowledge uptake and dissemination process were residents, senior physicians, and nurse practitioners. These findings have a number of potential implications; for example, allied health professionals, especially those with cross-team responsibilities, might be better utilized as information resources. Also, the sense of confusion and lack of structure around research knowledge uptake and sharing articulated by the teams might call for more formal integration of processes for introducing and integrating research findings into practice [47, 48], including better use of emerging technologies to facilitate knowledge use and consideration of a formal role, such as an information specialist, in care settings [23, 49, 50].

Like Wensing and colleagues' study of primary care teams that demonstrated low density values among practices [37], we also found that the exchange of research information (either providing or receiving) was not a fundamental tie binding these teams together. Perhaps this is not surprising given that the group's core function is the provision of health care. Nevertheless, these low values might be considered baseline measures of cohesiveness, and the expectation is that these values would increase if meaningful knowledge-exchange interventions were successfully implemented.

When discussing how research knowledge enters the team, quantitative findings point to senior doctors as the primary purveyors of information and key clinical decision makers, whereas in the interviews, senior doctors were more likely to say that residents bring the majority of new research to the team. This could be a matter of defining the difference between knowledge that is "new" and knowledge that is "used" (or applied). We found that although there were several organized events (continuing medical education, pharmaceutical lunches) where information was presented, there was a lack of formal or consistent process in place where the team could

collectively acquire, share, or apply knowledge. At the organizational level, there is a need to define and delineate the goals and objectives of the various meetings that PHCTs held so that appropriate and targeted knowledge sharing can occur. Our findings are consistent with those of Goldman and colleagues [51], who suggest that there is a need to ensure processes are in place to facilitate education (knowledge acquisition and sharing) in order to improve patient care. While it was acknowledged that a substantial amount of new information entered the team from pharmaceutical representatives (which resonates with the clinical information seeking or use literature, where a main source of "evidence" is from these commercial vendors [31, 52, 53]), our participants expressed some resistance to this. It has been argued that to truly improve the quality of primary health care, both improved access to [54] and more effective use of current and up-to-date evidence [55] are required.

Participants desired more formalized knowledge-sharing processes, confirming the recommendation to invest in the PHC infrastructure, including tools and mechanisms to facilitate knowledge management [56]. Several possibilities have been proposed, with varying degrees in the quantity and quality of empirical evidence available for these options. For example, while huge resources have been spent in mounting information technology (IT)-based solutions such as clinical decision support systems, electronic medical records, and a variety of health IT solutions more broadly, systematic reviews continually point to lack of uptake and/or lack of meaningful impact of these systems, except in the largest and best-resourced organizations [57]. Organizational structure and information and decision processes are often cited as barriers to successful implementation.

This research has clear implications for information professionals because PHCT members have a strong desire for more organization of their knowledge acquisition and sharing. This new role for information professionals could include being a part of PHCT as a human information intermediary or information specialist. Previous research has found this type of role, now often referred to as knowledge broker [58] but previously called "clinical librarian," to be beneficial in improving communication and knowledge sharing in teams, and, in the case of clinical librarians, there is evidence of some impact on patient outcomes when librarians participate in hospital-based clinical rounds [20, 23, 47, 48, 50]. However, this role has not been studied extensively in primary care settings, and the impact of knowledge broker roles in other settings is uncertain [59]. Evaluation of interventions that specify the type and scope of the information specialist or knowledge broker role, and its impact in different settings, is required. Models in which library services are shared across settings, using electronic communication, are evolving in other areas (e.g., Ontario's Public Health system and its focus on knowledge exchange processes [60, 61]) and could provide an excellent model for primary care.



Research has shown that having access to specialist and interprofessional care can improve patient outcomes [62]. In our study, quantitative findings indicated an underutilization of allied health professionals and other knowledge resources (such as electronic forums), despite the fact that allied health professionals were mentioned several times in the interviews. This has been found in other studies, where computer-based and library resources were underutilized [63]. Allied health professional team members tended to use more of a “push” model, such as “lunch and learns,” to share information with the team rather than a “pull” approach, where team members request information. It was unclear what the barrier to access was, however; lack of knowledge of resources or lack of skill to access them seemed to be the most probable. More research is needed to determine which, if any, team and/or program characteristics contribute to improvements in utilizing knowledge resources.

A suggested future area of research is a deeper exploration of the costs involved in training clinical staff to be more information savvy. Our data highlight two potentially troubling things: First, some professionals, in our case nurse practitioners, were highlighted as key knowledge sources with a high level of credibility and trust. However, at least one nurse practitioner in our sample indicated that her knowledge-brokering activities came with a cost, specifically the time used brokering knowledge was not available for clinical or research responsibilities. Second, respondents talked about the possibility of meetings designed for clinical knowledge sharing and updates, but current meetings were already identified as vague in their purpose and structure, and potentially inefficient. While at first glance, the nurse practitioner and specific meetings seem to hold potential for information sharing, the direct resource and indirect opportunity costs related to these health professionals and their clinics must be considered. A more clearly articulated information specialist role, with supported resources, might be more cost effective and allow health professionals to perform their clinical duties without being distracted by information management.

### Limitations

This exploratory study has several limitations. We examined a purposive sample of six PHCTs at two PHC sites to illustrate the phenomenon of information sharing in family health teams. Due to this small sample, our findings are not meant to be representative of or generalizable to other interprofessional health care teams. Those who did participate in this study might demonstrate a pro-EBP bias not shared by their colleagues, implying that unresponsive team members might be “laggards” with respect to innovation diffusion. Our study focused on interpersonal sources of information; we did not explicitly ask participants about personal use of databases, journals, or libraries. Our intention was geared toward generating hypotheses. More research is needed to understand

the role and function of knowledge in these teams and their effect on patient outcomes. Although SNA relies on self-report, we believe that our mixed methodology provides a novel and potentially useful approach to understanding these complex knowledge processes in busy and dynamic teams.

### CONCLUSION

Information sharing in interdisciplinary teams is a complex and multifaceted process. Our research has shown some of the complexities in that process and provided some insight into areas of strength, such as having access to a wide range of people and formats for knowledge sharing. We have also highlighted areas for improvement, such as formalizing modes of communication, better organizing knowledge-sharing activities, and improving the active use of allied health professionals. Further research is required to determine if outcomes differ between teams and why this might be so, according to practice-specific variables (e.g., funding/salary models, geography, time since team inception, etc.). There is also a need to determine if accessing and applying information actually changes practice behavior and impacts patient outcomes. Further research is required to determine what are effective ways of sharing knowledge in PHCTs and if, for example, resources like an information specialist or knowledge broker would be more effective and efficient ways to improve the quality and quantity of research-based knowledge being used in primary care settings.

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